National Aeronautics and Space Administration

technology opportunity

NASA's EBF3: The Future of Art-to-Part Manufacturing

Cutting costs, reducing waste, expanding capabilities

NASA is making tomorrow's rapid prototyping and manufacturing technology available today.

Companies are invited to license an innovative system for performing electron-beam freeform fabrication (EBF3) that offers significant advantages over traditional e-beam and laser-based systems. NASA's EBF3 system uses a wire-feed design to deliver quality parts that are better than cast and similar to wrought materials while optimizing material consumption. Multiple wires can be used to create new alloys or layered parts. The system also costs significantly less to build than others, enabling companies previously hesitant to enter the market to compete and win in the expanding rapid prototyping and manufacturing market.

Benefits

- **Lowest TCO**: Offers the lowest total cost of ownership through the low cost for a commercialized system as well as its low energy consumption (see below).
- **Quality parts**: Produces fully dense parts using real engineering alloys (e.g., Ti-6Al-4V and Al 2219) with no material waste.
- **Lower material costs**: Requires less material to make a quality part than with powder-based e-beam systems.
- **Multiple material manufacturing**: Allows multiple materials to be co-deposited, enabling fabrication of alloy-based and layered parts.
- **Environmentally friendly**: Makes it easier to comply with the regulations associated with chrome plating.
- **Lower power, higher safety**: Uses about 20 kV, lowering not only operation costs but also radiation, thereby improving safety conditions.
- **Versatile part envelope**: Creates the widest spectrum of quality parts of varying sizes up to 6" long (or even larger with scale-up).

Applications

Three-dimensional models for new designs

Custom parts and small-batch production

- Medical devices
- Motorcycle parts (exhaust systems, motors, radiators, sprockets)
- Sports equipment (designer golf clubs, rackets, baseball bats)
- Tool and die

Chrome plating

- Automobile parts (fenders, exhaust systems, headers, designer rims)
- Motorcycle parts (fenders, gas tanks, rim-and-spoke kits, kickstands)
- Bicycle parts
- Household appliances

Replacement parts in remote or hostile locations

- Military forward-operating locations
- Seafaring ships
- Offshore oil rigs
- Polar research stations

Technology Details

Companies currently providing only laser-based rapid prototyping and manufacturing services (e.g., lithography, sintering) can use NASA's EBF3 system to expand their offerings and take advantage of the benefits of electron-beam manufacturing (e.g., a wider variety of metal-based parts, reduced waste) without some of the drawbacks associated with powder-based e-beam systems (e.g., high power, 4-hour cooling period).

How it works

The system consists of an electron-beam gun, wire feeder, and positioning system enclosed in an aluminum vacuum chamber. Like other e-beam systems, the NASA system focuses the electron beam to melt a material, in this case metal wire, which is then accurately deposited layer by layer according to computer-aided design (CAD) data to fabricate a three-dimensional structural part without the need for a die or mold.

Unlike other e-beam systems, which operate at 60–200 kV, NASA's technology can create parts using about 20 kV of power. The system can be used to make parts from a wide range of materials (e.g., titanium, aluminum, nickel, stainless steel) as well as alloyed and layered parts via multiple wire feeders. The size of parts will be dependent upon the size of the system, which is scalable; NASA has been using the system to make parts 6" and smaller.

Why it is better

About 80% of the world's parts are 6" or smaller. Therefore, the EBF3 system's part envelope has the potential to produce the broadest cross section of replacement or new parts in the manufacturing market. NASA's EBF3 system is less expensive than other systems. NASA installed its system for $250K; however, however, a commercialized system is expected to cost significantly less. Furthermore, the EBF3's low-power design offers significantly reduced operating costs and minimizes radiation and the associated shielding required to comply with safety regulations. Other cost savings are possible because of the NASA system's reduced use of material compared to other systems. EBF3 uses a full 100% of the material for the part with no residual material contamination. This offers an advantage over powder-based e-beam systems, which require residual material to be recaptured and recertified before it can be reused. In addition, parts made with NASA's EBF3 system can be used or shipped immediately with only minimal need for cooling.

Because two or more wires can be fed into the system, EBF3 can be used to make multi-material parts. The system can create a wide variety of never-before-possible alloy-based parts by feeding two wires simultaneously. Alternatively, the wires can be fed sequentially to create layered parts with better surface properties. For example, EBF3 offers a high-quality alternative to traditional chrome plating while allowing manufacturers to better comply with environmental regulations. The technology works exceptionally well with such alloys as Ti-6Al-4V and Al 2219.

Patents

NASA has patented this technology (#7,168,935) and has other patents pending.

Licensing and Partnering Opportunities

This technology is being made available as part of NASA's Innovative Partnerships Program (IPP), which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Wire-Feed E-Beam Freeform Fabrication technology (MSC-23518-1) for commercial applications.

For More Information

If you would like more information or want to pursue transfer of this technology, please contact:

msc23518@fuentek.com

For more information about other technology licensing and partnering opportunities, please visit:

Innovations Partnership Office
NASA's Johnson Space Center
http://technology.jsc.nasa.gov

MSC-23518-1
03.03.09

Fuentek is a contractor to NASA's Innovative Partnerships Program, providing support for the access and transfer of technology.